Project Management Challenge 2006:
A Future of Space Exploration
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The future of space exploration over the next several decades is filled with exciting opportunities and daunting challenges. I am truly thankful to be asked to assume the role of Chief Engineer at this time. The role of the engineering community in this great venture of exploration will be ever more important as we develop the technologies that will allow us, the citizens of planet Earth, to continue to expand as a space faring society.

James Watt's patent of the steam locomotive in 1784 started our journey toward becoming a global civilization. Prior to the engineering accomplishment of harnessing the power of steam we traveled at the whim of the weather. With steam power we opened up the oceans and the interiors of continents to explorers and merchants. So too in the next decades engineers will develop, not only the technologies to allow us to return to the moon and on to Mars, but will also help open outer space to our society.

NASA has been given a grand new challenge with the Vision for Space Exploration: to achieve the bold goals of finishing the International Space Station, building the next generation Crew Exploration Vehicle, returning humans to the Moon, and ultimately sending humans to and safely returning them from Mars. NASA Administrator Dr. Michael Griffin has called this our "best mission statement in forty years," and I couldn't agree more.

Let's take these challenges one by one while hopefully keeping it brief:

First finishing the International Space Station:

As laid out in the newly released "2006 NASA Strategic Plan", NASA will return the Space Shuttle to flight and complete the International Space Station before retiring the Shuttle in 2010. NASA also recently met with the international partners where they agreed upon the future of Station and a Shuttle manifest to complete our obligations and bring the Station to its full fruition. The completion of the International Space Station will help promote long-term exploration goals by helping us learn how to work in space and by giving us insight into the stress of long duration spaceflight on the human body and mind. The Space Station also sets the stage for going back to the Moon and on to Mars with the example of how exploration can bring nations together for common goals.

The second task is to build the next generation Crew Exploration Vehicle or CEV:

The CEV is America's first new human spacecraft in 30 years. I want to pause here a moment to repeat that fact – The CEV is America's first new human spacecraft in 30years! Isn't that amazing! This fact speaks to why the Administrator, as well as myself are so high on this new mission statement. This is a new vehicle and system – it

is neither Shuttle nor Apollo – that will provide us with the capability to once again to allow humans to travel beyond low Earth orbit. Something we also have not done in more than 30 years. The CEV is a key element of the Constellation Program, which will help NASA realize the Vision for Space Exploration. We have already made great strides in the development of the CEV. In January the refinements for the CEV, Phase II were announced. The requirements are based on future exploration mission needs and the desire to fly the first CEV mission as close as possible to 2010, when the space shuttle will be retired. These advances with the CEV illustrate NASA's commitment to move forward to achieve the goals of the Vision for Exploration. – And not only to move forward, but to do so aggressively towards meeting our target dates laid out in the Vision.

The third task is to return humans to the Moon and establish a permanent presence:

Again, this is not Apollo redux. A return to the moon will further develop the tools and capabilities we need to travel on to Mars and expand our capabilities as a space faring society. The new capabilities necessary to return to the moon will challenge the engineering communities of several nations as we develop the highly technical propulsion systems, life support systems, and communication systems to support the long stays needed to prepare for Mars and beyond. The fantastic missions of the Apollo program showed that we could travel away from the planet Earth. This next generation of space travel must demonstrate that we can work and use space for science, exploration, and commercial ventures. The return to the Moon will help all of these goals.

This brings us to the fruition of the Vision - to ultimately send humans to and safely return them from Mars:

As I look to the next 50 years of space exploration, the human exploration of Mars remains the goal that is most visible and difficult. To leave this planet and establish a presence on a new planet is unprecedented in its complexity and potential. For the first time in centuries we will leave the homeport and travel to a destination so far removed from home that when visible but a dot to the naked eye. This time though the challenges are greater. Unlike the voyages of exploration from centuries past we know that we will not have a ready supply of water or food or peoples to help us on these travels. We will have to develop new technologies not only in propulsion, but in life support, communication, medicine, and the tools to maintain the human psyche when it travels so far from home. We will also have to develop systems that are inherently reliable and very adaptable as we deal with the surprises of a new environment.

These goals set forth for NASA are daunting and complex. The question the NASA community and the technical community in general is how best to achieve these goals. Towards this end I believe that we need to follow some simple principles that will allow us to achieve technical excellence.

1. Clearly Documented Policies and Procedures
Given the complexity and uniqueness of the systems that NASA develops and deploys, clear policies and procedures are essential to mission success. Simply put, we cannot

afford to make things up as we go along. The existence of policies and procedures does not guarantee success – they must be properly implemented – but their absence is a surefire recipe for disaster. The Office of the Chief Engineer will ensure that effective, clearly documented policies and procedures are in place to facilitate optimal performance, rigor, and efficiency among NASA's technical workforce.

2. Effective Training and Development

NASA is fortunate that the importance of its mission allows it to attract and retain the most capable technical workforce in the world. NASA in turn bears responsibility for providing this workforce with the training and development necessary to carry out the Agency's missions. As Louis Pasteur once said, "Fortune favors the prepared mind." NASA's Academy of Program/Project and Engineering Leadership (APPEL) is the institution responsible for the development of program/project and engineering leaders and teams within NASA. Its programs must set the industry standard for engineering and project management training if our missions are to succeed. The Office of the Chief Engineer will provide full support for training and development activities that will allow NASA to maximize the abilities of its technical workforce.

3. Engineering Excellence

Risk is an inherent factor in any spacecraft development. Proper risk management entails striking a balance between the tensions of program/project management and engineering independence. Engineering rigor cannot be sacrificed for schedules and budgets, and likewise programmatic concerns cannot be overlooked in the development of the technical approach to a given program or project. The Office of the Chief Engineer will provide leadership for Engineering Excellence at NASA, and will oversee all activities related to the exercise of technical authority across the Agency.

4. Continuous Communications

Communication lies at the heart of all leadership and management challenges. Similarly, every major failure in NASA's history has stemmed in part from poor communication. Among the Agency's technical workforce, communication takes myriad forms: continuous risk management, knowledge management, knowledge sharing, dissemination of best practices and lessons learned, and continuous learning, to name but a few. The complexity of NASA's programs and projects demands an open, vigorous culture of continuous communication that flourishes and empowers individuals at all levels to raise concerns without fear of adverse consequences. The Office of the Chief Engineer will promote a culture of continuous communications by extending its own communication outreach efforts across the technical workforce.

These principles set the framework for technical excellence, but they are only the framework. In addition there are roles and responsibilities necessary to make this goal of technical excellence a reality.

First is personal accountability. Personal accountability means that each individual must understand and believe that he or she is responsible for the success of the mission. Each person, regardless of position or area of responsibility, contributes to success. What we

do is so complex and unique that each and every component must work for us to be successful. All of us working in the NASA technical community need to possess the knowledge and confidence to speak up when something is amiss in either our or someone else's area of responsibility. When people fail to speak up, the results can be disastrous.

In addition to personal accountability, there is also organizational responsibility to provide the proper training, tools, and environment.

Training consists of more than just transferring a set of skills. In addition to ensuring that our people are knowledgeable about standards, specifications, processes and procedures, our training programs including APPEL is rooted in an engineering philosophy that grounds our approach to technical work and decision-making. These offerings must give historical and philosophical perspectives that teach and reinforce our organizational values and beliefs.

Tools range from the facilities and resources necessary to do our jobs to the clearly documented policies, processes, and procedures that allow us to work safely and efficiently. Our policies and procedures should be consistent with and reinforce our organizational beliefs and values.

The environment is one in which we can pursue technical excellence to the best of our individual and collective abilities. Providing the proper environment for technical excellence means establishing regular and open communication so that individuals feel comfortable exercising their personal responsibility. It also requires ensuring that those who prefer to remain in the technical field (instead of management) have a satisfying and rewarding career track. One component of this will be a Technical Fellows Program which the Office of the Chief is currently in the process of defining. Technical Fellows will be Agency leaders of their engineering discipline and will be a resource for technical authorities. They will be selected by the NASA Chief Engineer as the "best of the best of the Agency's subject matter experts in their discipline.

In short, technical excellence requires a shared commitment in which everyone has a role to play. I welcome your ideas about how we can best pursue this goal together.

Fortunately we will not be pursuing these goals alone. The exploration of Mars is already well underway with a robust robotics program. The Spirit and Opportunity rovers currently traversing Mars show the benefit of international cooperation, as German made sensors on these craft continue to gather data long past the expected lifespan. The very capable international fleet of orbiters; Mars Global Surveyor, Mars Odyssey, and Mars Express, provide us with daily updates about the red planet. These international orbiters also serve as relays for the data from the rovers to the Earth, providing a much greater data return. In our latest success the Mars Reconnaissance Orbiter made a flawless entry into Mars orbit on March 10th. This craft is an engineering and scientific marvel expected to send back more data than all previous Mars probes combined. In the words of Project Manager Jim Graf "We are sending the most capable spacecraft that we have ever sent to Mars, and the most technologically advanced payload we have ever sent to

another planet." The robotic missions to come will further serve to gather the necessary data to lay the framework for the requirements for a human landing.

As previously mentioned these are daunting tasks, but with international cooperation and private sector partnerships costs can be mitigated and innovation maximized. As in the past this program of exploration holds the promise of technological advances in spin-off areas such as medicine, communications, and energy production to the potential benefit of all humanity.

The future of engineering, propelled by this new Vision, is exciting and challenging. Much like Apollo did a generation ago the push to the Moon, Mars, and beyond offers an opportunity to excite future generations about the possibilities of science and engineering. In a previous generation President Kennedy challenged America and the American engineering community responded. As a child watching the Apollo astronauts walk on the Moon I was thrilled and it encouraged me along with many others to pursue a career in science and engineering and in space exploration. We can be that encouragement again. The challenge of establishing a permanent Moon presence and building an infrastructure that can safely sustain humans in space and at Mars will be, I believe, the greatest engineering feat in history.

The potential engineering, scientific, and societal benefits are great, but these advances alone are not why we undertake these endeavors. We also undertake this Vision because humankind is an exploring species; we are always dreaming of something more, always searching for the next horizon, whether the distant lands across the oceans of centuries past or the distant planets we will reach in this new century. The next challenge for us is to make real the things that people have been dreaming of for centuries – to venture beyond the Earth and become a space faring civilization.